
REMARKS

This amendment is a full and timely response to the aforementioned Office Action, the period for response being extended one-month through A Request for Extension of Time submitted concurrently herewith. By this amendment, Applicants have amended the drawings to improve figure labeling. Furthermore, Applicants have amended claim 1 to recite oxidizing the surface of the copper film through a voltage applied between the cathode member and the copper film. Claim 23 was amended to recite oxidizing the surface of the copper film through a voltage applied between the cathode member and the copper film, wherein the cathode member functions as a cathode and the polished surface functions as an anode forming a chelate film of an oxidized copper film. Claim 25 was amended to recite oxidizing the surface of the metal film through an anode oxidation process and forming a chelate film of oxidized copper on the oxidated metal film further define the invention. Support for the changes to claims 1, 23, and 25 can be found variously throughout the specification and drawings. For example, changes to claims 1 and 23 can be found in the specification at page 38, lines 3-13, and changes to claim 25 can be found in the specification at page 38, lines 3-22; page 39, lines 13-21; and page 41, lines 2-6. Claims 4-7, 11, 31, 38, 40-45, 47, and 50-52 to improve structure and form. No new matter has been added. Claims 1-111 are pending, in which claims 1-52 are elected, and claims 53-111 have been withdrawn.

Objection to the Specification

The disclosure was objected to for alleged informalities. In particular, the Office Action alleges that Figures 25D, 25E, and 25F are not of record in the application file. Applicants thank the Examiner for providing suggestions to amend the specification, and have amended the specification so that the reference to Figures 25D, 25E, and 25F is now a reference to Figures 26A, 26B, and 26C, respectively. Applicants have further amended the specification so that references to other figures are as follows: Figs. 2D-2E are now 2A and 2B, respectively; Figs. 3F and 3G are now 3A and 3B, respectively; Figs. 4H and 4I are now 4A and 4B, respectively; Figs. 5J-5L are now 5A-5C, respectively. Applicants have attached new drawing sheets 1-5, which incorporate the above changes. Applicants have further attached an annotated version of

sheets 1-5 describing each change is attached. Accordingly, Applicants respectfully request that the objection to the disclosure be withdrawn.

Rejections Under 35 U.S.C. §112

Claims 31 and 50 were rejected under 35 U.S.C. §112, second paragraph for alleged indefiniteness. Applicants have amended claims 31 and 50 in a manner that addresses and remedies the alleged §112 issues. In particular, claim 31 has been amended to include, among other things, the hole is in communication with the bottom surface of the groove, and claim 50 has been amended to change “copper film” to “chelate film.” Accordingly, Applicants request that the rejection of claims 31 and 50 under §112, second paragraph be withdrawn.

Rejections Under 35 U.S.C. §102

Claims 25-34, 38, 39, 41, and 46-52 were rejected under 35 U.S.C. §102(e) as anticipated by *Wang et al.*, U.S. Patent No. 6,440,295. Applicants respectfully traverse this rejection.

Independent claim 25 recites a method for production of a semiconductor device, comprising the steps of forming at least a groove or hole in an insulation film formed on a substrate, stacking a metal film on said insulation film so as to bury the groove or hole, interposing an electrolytic solution between a electrode member and the metal film, oxidizing the surface of the metal film through an anode oxidation process; forming a chelate film of oxidized copper on the oxidated metal film; removing the chelate film from the surface of the metal film, and selectively repeating the above step of removing the chelate film until the unevenness of the surface of the metal film is reduced.

For example, in Figs. 1B-5L, contact holes CH and interconnection grooves M are formed in the substrate 101. A barrier film 103 is formed on the surface of the insulation layers and in the contact holes CH and interconnection grooves M. An electrolytic solution EL or an additive is added between an electrode member 120 and a metal film 105. The metal film 105 is oxidized and is chelated by the electrolytic solution EL to form chelate film 106. Projecting portions of chelate film 106 are then selectively removed.

Wang discloses a method for electropolishing a surface of copper by ionizing and dissolving the solid copper. In this process, a dielectric layer 123 is formed on top of a substrate

124. A damascene process is then performed so that trenches 125 and gates 126 can be formed in the dielectric layer 123. Next, a barrier layer 122 is formed on top of the dielectric layer 123. Alternatively, *Wang* discloses that a metal layer 121 can be formed on top of the barrier layer 122 or formed on top of the dielectric layer 123. The metal layer is then electropolished. Electropolishing is performed by controlling the polarity of cathodes 1-3 and by controlling the portions of the wafer contacted by an electrolyte 34. The uniformity and rate of polishing is controlled by the amount of current supplied by power supplies 11-13. The wafer is electropolished until the metal layer 121 is removed from the barrier layer 122, while the metal layer 121 remains within the trenches 125. See col. 7, lines 1-col. 8, line 25, col. 9, line 64-col. 10, line 16, col. 10, line 61-col. 12, line 14.

In contrast, claim 25 recites, among other things, oxidizing the surface of the metal film through an anodic oxidation process and forming a chelate film of oxidized copper on the oxidized metal film. *Wang* fails to disclose, teach, or suggest at least the aforementioned claim elements. In particular, *Wang* fails to disclose, teach, or suggest at least oxidizing the surface of the metal film and forming a chelate film as recited in the claim.

To properly anticipate a claim, the document must disclose, explicitly or implicitly, each and every feature recited in the claim. See *Verdegall Bros. v. Union Oil Co. of Calif.*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Because *Wang* fails to disclose, teach, or suggest every element recited in claim 25, it follows that *Wang* does not anticipate the claim. Thus, Applicants respectfully request that the rejection of claim 25 under 35 U.S.C. §102 be withdrawn, and this claim be allowed.

Claims 26-34, 38, 39, 41, and 46-52 depend from claim 25. By virtue of this dependency, Applicants submit that claims 26-34, 38, 39, 41, and 46-52 are allowable for at least the same reasons given above, with respect to claim 25. In addition, each of these claims are further distinguished over *Wang* by the additional elements recited therein, respectively, particularly within each claimed combination.

Rejections Under 35 U.S.C. §103

Claims 1-24 were rejected under 35 U.S.C. §103(a) as obvious over *Yamazaki et al.*, U.S. Patent No., 6,242,343 in view of *Wang* and further in view of *Sandhu et al.*, U.S. Patent No. 6,099,604. Applicants respectfully traverse this rejection.

Independent claim 1 recites a method for producing a semiconductor device, comprising the steps of forming an interconnection groove in an insulation film formed on a substrate; stacking a copper film having unevenness on its surface corresponding to the step difference of the interconnection groove on the entire surface of the insulation film so as to bury the interconnection groove; interposing an electrolytic solution comprising a chelating agent between a cathode member and the copper film functioning as an anode, applying a voltage between the cathode member and the copper film to oxidize the surface of the copper film by anodic oxidation; selectively removing a projecting portion of the chelate film corresponding to unevenness of the copper film to expose the copper film of the projecting portion at its surface; and repeating the above chelate film forming step and the chelate film removing step until the projecting portion of the copper film is flattened.

Independent claim 23 recites a polishing method for polishing an object having a copper film on the surface to be polished, comprising the steps of interposing an electrolytic solution including a chelating agent between a cathode member and the polished surface, oxidizing the surface of the copper film through a voltage applied between the cathode member and the copper film, wherein the cathode member functions as a cathode and the polished surface functions as an anode forming a chelate film of an oxidized copper film, selectively removing a projecting portion of the chelate film corresponding to the shape of the copper film to expose the copper film of the projecting portion at its surface, and repeating the above chelate film forming step and the chelate film removing step until the projecting portion of the copper film is flattened.

Yamazaki discloses a method of polishing a surface of copper by a combination of electropolishing and chemical mechanical polishing (CMP). In performing this method, a base film 102 is formed on a substrate, and an aluminum film is used to form wirings. The aluminum film 102 is patterned and wirings or electrodes 103 and 104 are formed on the first layer. Next, an interlayer insulating film is formed on the base film 102. An opening is then formed that reaches the wirings or electrodes 103 and 104. The aluminum film is naturally oxidized and

removed. Next, a polishing process is performed by using a mixture of silica sol and an electrolytic solution for use in chemical mechanical polishing, wherein portions of protruding wirings 106 and 107 are selectively polished and at the same time used as the anodes. The Office Action acknowledges that *Yamazaki* fails to disclose repeating the above chelate film forming step and the chelate film removing step until the projecting portion of the copper film is flattened. Applicants note further that *Yamazaki* also fails to disclose, teach, or suggest any details related to a process of electropolishing.

Sandhu discloses a method of polishing a surface of copper by CMP using a slurry in which chelating agents are mixed. Further, *Sandhu* discloses that the incorporation of chelating agents in a slurry for CMP processing can allow for preferential removal of surface moieties from a wafer. In performing this method, the wafer is pressed against a polishing surface of a polishing pad 40. The slurry with the chelating agent is then deposited on the polishing pad. The wafer and polishing pad are moved so that additional moieties can be removed. Next, when the desired amount of abrasion is removed, the CMP process is stopped. *Sandhu*, however, fails to disclose, teach, or suggest applying an electrical current or voltage in performing the polishing method.

In contrast, claim 1 recites, among other things, applying a voltage between the cathode member and the copper film to oxidize the surface of the copper film by anodic oxidation. Similarly, claim 23 recites, among other things, applying a voltage between the cathode member functioning as a cathode and the polished surface functioning as an anode to oxidize the surface of the copper film and forming a chelate film of oxidized copper. *Wang*, *Yamazaki*, and *Sandhu* either singly or combined, fail to disclose, teach, or suggest at least oxidizing the surface of a metal film as needed in claims 1 and 23.

To establish *prima facie* obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). Moreover, obviousness "cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination." *ACS Hosp. Sys. V. Montefiore Hosp.*, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984). Because neither *Wang*, *Yamazaki*, nor *Sandhu* either singly or combined, disclose, teach, or suggest at least oxidizing the surface of the metal film and forming a chelate

film as recited in the claim, Applicants submit that a *prima facie* case for obviousness has not been established. Thus, Applicants respectfully request that the rejections of claims 1 and 23 under 35 U.S.C. §103 be withdrawn, and these claims allowed.

Claims 2-22 depend from claim 1, and claim 24 depends from claim 23. By virtue of this dependency, Applicants submit that claims 2-22 and 24 are allowable for at least the same reasons given above, with respect to claims 1 and 23, respectively. In addition, each of these claims is further distinguished over *Wang*, *Yamazaki*, and *Sandhu* by the additional elements recited therein, respectively, particularly within each claimed combination.

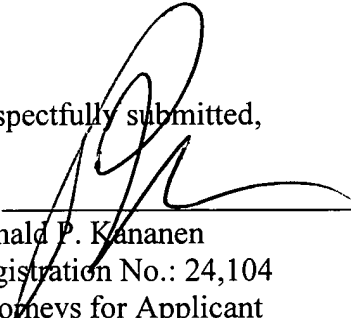
Claims 35-37 were rejected under 35 U.S.C. §103(a) as obvious over *Wang* in view of *Sandhu*. Claims 40 and 42 were rejected under 35 U.S.C. §103(a) as obvious over *Wang* in view of *Uzoh et al.*, U.S. Patent No. 5,807,165. Claims 43-45 were rejected under 35 U.S.C. §103(a) as obvious over *Wang* in view of *Forano*, U.S. Patent No. 6,149,781. Claims 35-37, 40, and 42-45 depend from claim 23. By virtue of this dependency, Applicants submit that claims 35-37, 40, and 42-45 are allowable for at least the same reasons given above with respect to claim 1, and are further distinguished over *Wang*, *Sandhu*, *Uzoh*, and *Forano*, where applicable, by the additional elements recited therein, particularly within each respective claimed combination. Applicants respectfully request, therefore, that the rejection of claims 35-37, 40, and 42-45 under 35 U.S.C. §103 be withdrawn, and these claims be allowed.

Conclusion

Based on at least the foregoing amendments and remarks, Applicants submit that claims 1-52 are allowable, and this application is in condition for allowance. Accordingly, Applicants request favorable reexamination and reconsideration of the application. In the event the Examiner has any comments or suggestions for placing the application in even better form, Applicants request that the Examiner contact the undersigned attorney at the number listed below.

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Respectfully submitted,

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